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DRAFT
FIELD SAMPLING PLAN FOR AREAS 12 and 13

OF THE
CAMP EDWARDS IMPACT AREA GROUNDWATER QUALITY STUDY

MASSACHUSETTS MILITARY RESERVATION
CAPE COD, MASSACHUSETTS

Prepared for

NATIONAL GUARD BUREAU
ARLINGTON, VIRGINIA

Prepared by

OGDEN ENVIRONMENTAL AND ENERGY SERVICES
239 Littleton Road, Suite 1B
Westford, Massachusetts 01886

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September 2, 1997

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DISCLAIMER:

This document has been prepared pursuant to a government administrative order (U.S. EPA Region I SDWA Docket No. I-97-1019) and is subject to approval by the U.S. Environmental Protection Agency. The opinions, findings, and conclusions expressed are those of the authors and not necessarily those of the Environmental Protection Agency.

A.11 Area 12 and 13 Field Sampling Plan

A.11.1 Background and Focal Area(s)

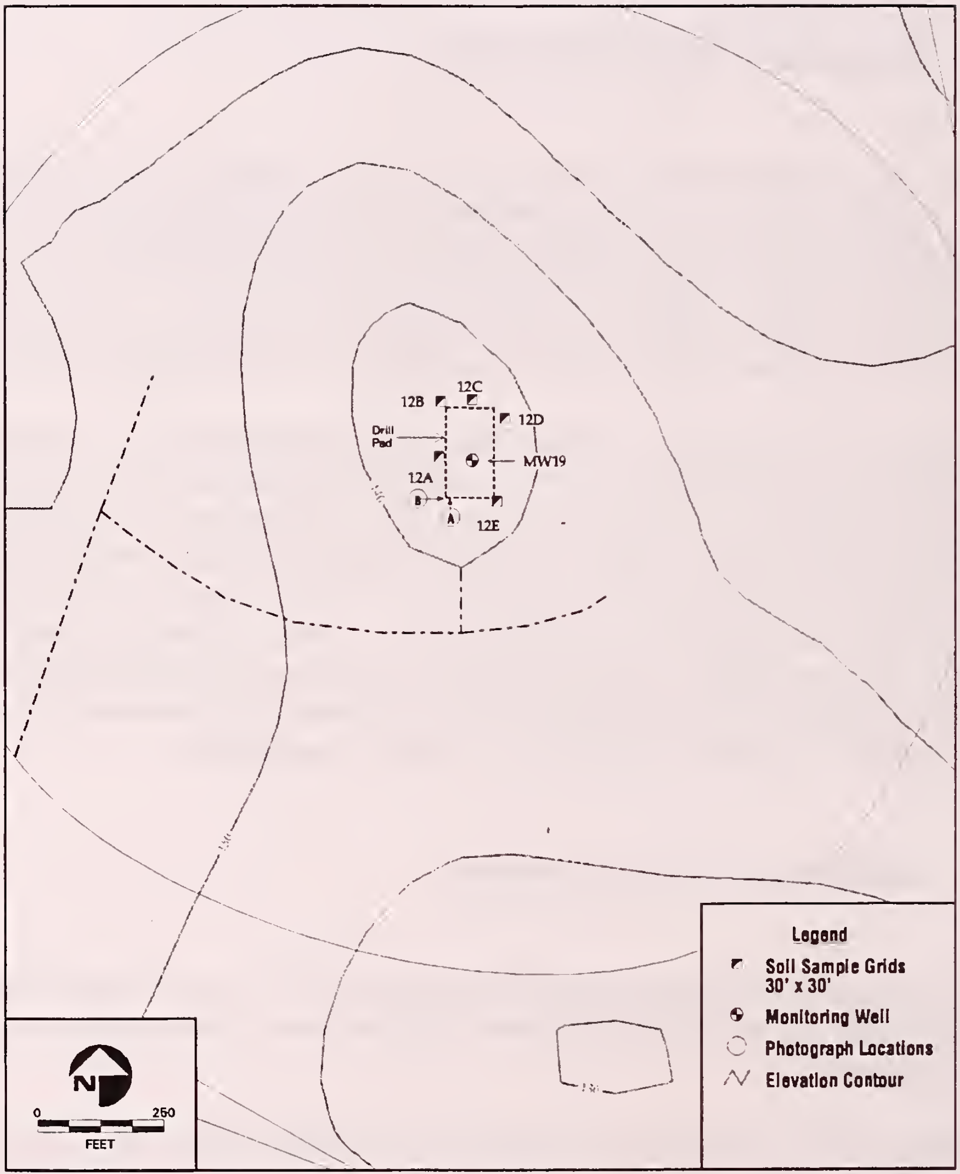
Areas 12 and 13 are both Demo Areas, which are restricted access areas indicated with large circles on the maps. Area 12 is Demo Area 1, located north of Forestdale Road as indicated in Figure A.11-1. Approximately two acres within Demo Area 1, which lie in the topographic low, have been used for demolition activities in the past. The area is relatively flat and clear of vegetation. There are visual signs of demolition activity consisting of small craters in this area. The flat cratered area is a focal area. The remainder of Demo Area 1 is densely vegetated and appears undisturbed.

Area 13 is Demo Area 2, located north of Gibbs Road as indicated in Figure A.11-2. Approximately 30 acres within Demo Area 2 appear to have been used for demolition activities. The 30-acre area consists of the topographic low portion of the area and the hill leading up to the bunker on the eastern boundary of Demo Area 2. This hill was graded during engineering work performed on the bunker within the last 6 months, and it is unvegetated. There is evidence of recent demolition activity on this hill consisting of four demolition craters. These craters are a focal area. The topographic low has visual signs of demolition activity consisting of demolition craters and only young growth of vegetation. The topographic low is a focal area. The remainder of Demo Area 2 is covered with tall trees and dense undergrowth and appears undisturbed.

A.11.2 Sampling & Analysis Methods

Areas 12 and 13 sampling will include surface soil at each focal area. Areas 12 and 13 sampling will also include subsurface soil and groundwater based on the potential for contaminants to migrate into deeper soils or groundwater.

Sample collection will be consistent with MMR Sops, the Ogden Health and Safety Guidelines, Attachment A: Field Guide to High Explosives, and the EPA Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities (October 31, 1996). Areas 12&13 are in the Impact Area, therefore all samples with detectable levels of explosives by the colorimetric analysis will be analyzed by EPA Method 8330. The subsurface soil and groundwater sampling protocols described in Section 4.0 of the Action Plan will be used.



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Area 12: Demo Area 1

FIGURE

A.11-1

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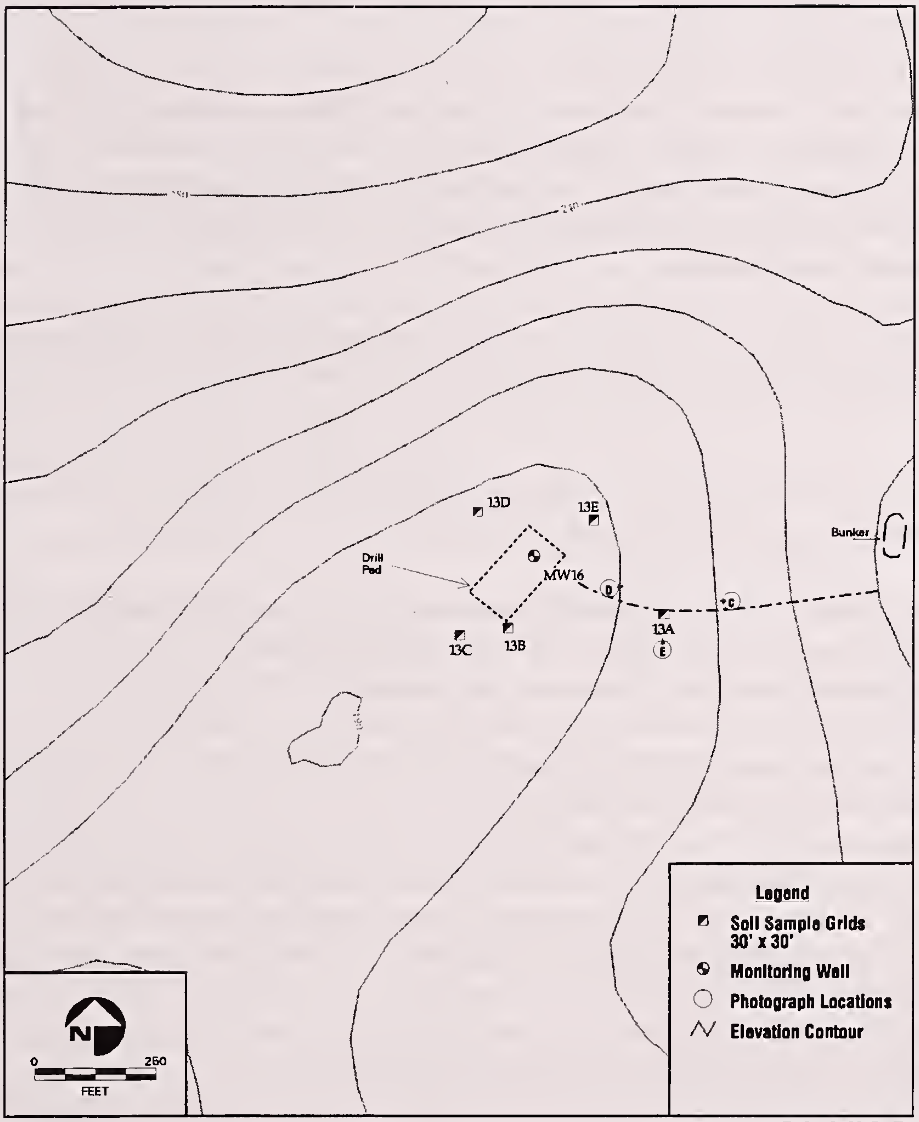

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Area 13: Demo Area 2

FIGURE

A.11-2

Hand Auger Sampling

A representative portion of each focal area will be sampled, as indicated in Figures A.11-1 and A.11-2. All grids will be placed in areas with visual signs of demolition activity.

- Area 12: Five grids will be located around the perimeter of the drill pad located in the topographic low. There is information from the archive search interviews that suggests that the basin may have been a deeper hole that was filled, although this information is not substantiated by historical topographical maps. The depths of hand augered samples may be modified from 0-6 and 18-24 inches after the boring log for MW-19 is available and has been discussed with EPA and other stakeholders.

- Area 13: Four grids will be placed around the perimeter of the drill pad located in the topographic low. One grid will be placed on the hill, which has several demolition craters.

Each soil boring grid will consist of nine sample points spaced ten feet apart. The following protocol will be followed for hand augering:

1. A 0-6" soil sample will be collected from each of the nine sample points in a grid;
2. soil from each sample point will be placed in a headspace jar;
3. the remaining soil from each of the nine sample points will be composited in accordance with Section 8.1 of the EPA Standard Guide and Attachment A of this FSP;
4. headspace measurements will be collected from each of the nine 0-6" samples and recorded in the space provided on the hand auger log;
5. a VOC grab sample will be collected from one sample point based on the following priority of observations: 1)highest response on the FID, 2) visual signs of contamination, 3) the central grid location (a fresh soil sample will be collected adjacent to the sample point);
6. the composite sample will be submitted for explosives, inorganics, and other analytes;
7. when the analytical results from the 0-6" sample are available, an 18-24" sample will be collected and composited as described above for explosives, inorganics, and any other analytes (except VOC) that are detected in the 0-6" sample;
8. an 18-24" sample will be selected for VOC analysis based on screening with an FID as described in steps 1-5 above.

Barber Rig Drilling

A boring will be advanced to bedrock at each of the areas as indicated in Figures A.11-1 and A.11-2, and completed as nested shallow and deep monitoring wells. The decision on well depth will be made in consultation with EPA. These borings will be completed using a Barber Rig.

Prior to the onset of the investigation, the sites will be intrusively cleared of UXO to a depth of two feet below grade. Additional clearance will occur from a depth of two feet to 10 feet below grade. A down-hole magnetometer will be lowered into the hole prior to advancing the auger in two-foot intervals. After completion of the next two-foot interval, 4" PVC will be inserted into the borehole and the rig will be moved off of the hole prior to magnetic survey of the next interval. The boring locations will be considered clear when a depth of ten feet is reached without encountering any magnetic anomalies.

The following activities will occur (every sample with explosives detected by the colorimetric method will also be analyzed by Method 8330):

1. A 0-6" sample will be collected and submitted for explosives, inorganics, and all other analytes;
2. From ten feet below grade until the water table is encountered, a soil sample will be collected every ten feet using a split spoon;
3. The 10-12' interval will be FID screened and submitted for explosives, inorganics, and other analytes;
4. The 20-22' interval will be FID screened and submitted for explosives, and inorganics;
5. Each sample below the 20-22' interval will be screened with an FID and sampled for explosives (submitted ON HOLD) and inorganic analysis;
6. The soil samples submitted ON HOLD for explosives will be analyzed only if explosives are detected in the 10-12' or 20-22' sample interval; and
7. Each sample below the 20-22' interval will be sampled for the other analytes only if there is a response on the FID.
8. Based on the results of the 0-6" sample, an 18-24" grab sample may be collected with a hand auger and submitted for explosives, inorganics, and other analytes as directed by the Field Program Manager.
9. The boring will be advanced 15 feet from refusal to confirm that bedrock has been encountered.

From the water table to the completion of the boring, soil will be sampled from the cyclone for lithology. Groundwater samples will be collected at every ten feet during advancement of the borings and will be submitted for laboratory analysis of explosives and VOCs. Wells will be screened as described in Section 4.2.2 of the Action Plan.

Table A.11-1 lists sample numbers and analytical requirements for the areas to be investigated.

Table A.11-1: Samples to be collected from Areas 12 and 13

MMR Soil Samples from Hand Auger Grids						Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Grid	Depth	Type	MMR ID	EPA/Ogden ID	Cont:	8oz	8oz	8oz		4 oz.	8 oz.			4 oz.*	
12	12A	0-6	grab	71BS12AXAX01XA	B12AAA						X					
			comp	71BS12AXAX01XA	B12AAA		X		X			X	X	X	X	X
		18-24	grab	71BS12AXBX01XA	B12ABA						#					
			comp	71BS12AXBX01XA	B12ABA		#		#			#	#	#	#	#
	12B	0-6	grab	71BS12BXAX01XA	B12BAA						X					
			comp	71BS12BXAX01XA	B12BAA		X		X			X	X	X	X	X
		18-24	grab	71BS12BXBX01XA	B12BBA						#					
			comp	71BS12BXBX01XA	B12BBA		#		#			#	#	#	#	#
	12C	0-6	grab	71BS12CXAX01XA	B12CAA						X					
			comp	71BS12CXAX01XA	B12CAA		X		X			X	X	X	X	X
		18-24	grab	71BS12CXBX01XA	B12CBA						#					
			comp	71BS12CXBX01XA	B12CBA		#		#			#	#	#	#	#
	12D	0-6	grab	71BS12DXAX01XA	B12DAA						X					
			comp	71BS12DXAX01XA	B12DAA		X		X			X	X	X	X	X
		18-24	grab	71BS12DXBX01XA	B12DBA						#					
			comp	71BS12DXBX01XA	B12DBA		#		#			#	#	#	#	#
	12E	0-6	grab	71BS12EXAX01XA	B12EAA						X					
			comp	71BS12EXAX01XA	B12EAA		X		X			X	X	X	X	X
		18-24	grab	71BS12EXBX01XA	B12EBA						#					
			comp	71BS12EXBX01XA	B12EBA		#		#			#	#	#	#	#
13	13A	0-6	grab	71BS13AXAX01XA	B13AAA						X					
			comp	71BS13AXAX01XA	B13AAA		X		X			X	X	X	X	X
		18-24	grab	71BS13AXBX01XA	B13ABA						#					
			comp	71BS13AXBX01XA	B13ABA		#		#			#	#	#	#	#
	13B	0-6	grab	71BS13BXAX01XA	B13BAA						X					
			comp	71BS13BXAX01XA	B13BAA		X		X			X	X	X	X	X
		18-24	grab	71BS13BXBX01XA	B13BBA						#					
			comp	71BS13BXBX01XA	B13BBA		#		#			#	#	#	#	#

X = to be collected and submitted to laboratory

= to be collected after results from the 0-6" sample are received

MMR Soil Samples from Hand Auger Grids						Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
	13C	0-6	grab	71BS13CXAX01XA	B13CAA						X					
			comp	71BS13CXAX01XA	B13CAA		X		X			X	X	X	X	X
		18-24	grab	71BS13CXBX01XA	B13CBA						#					
			comp	71BS13CXBX01XA	B13CBA		#		#			#	#	#	#	#
	13D	0-6	grab	71BS13DXAX01XA	B13DAA						X					
			comp	71BS13DXAX01XA	B13DAA		X		X			X	X	X	X	X
		18-24	grab	71BS13DXBX01XA	B13DBA						#					
			comp	71BS13DXBX01XA	B13DBA		#		#			#	#	#	#	#
	13E	0-6	grab	71BS13EXAX01XA	B13EAA						X					
			comp	71BS13EXAX01XA	B13EAA		X		X			X	X	X	X	X
		18-24	grab	71BS13EXBX01XA	B13EBA						#					
			comp	71BS13EXBX01XA	B13EBA		#		#			#	#	#	#	#

X = to be collected and submitted to laboratory

# = to be collected after results from the 0-6" sample are received

MMR Subsurface Soil Samples from Borings					Parameters:	Explosives (colorimetric)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
Area	Loc.	Depth	MMR ID	EPA/Ogden ID	Cont.	8oz	8oz	8oz		4oz	8 oz.			4oz	
13	MW16	A(0-6")	71MS16DXAX01XA	S16DAA		**X**		**X**		**X**	**X**	**X**	**X**	**X**	**X**
		B(18-24")	71MS16DXBX01XA	S16DBA		@		@		@	@	@	@	@	@
		C(10-12')	71MS16DXCX01XA	S16DCA		**X**		**X**		**X**	**X**	**X**	**X**	**X**	**X**
		D(20-22')	71MS16DXDX01XA	S16DDA		**X**		**X**		*	*	*	*	*	*
		E	71MS16DXEX01XA	S16DEA		X		**X**		*	*	*	*	*	*
		F	71MS16DXFX01XA	S16DFA		X		**X**		*	*	*	*	*	*
		G	71MS16DXGX01XA	S16DGA		X		**X**		*	*	*	*	*	*
		H	71MS16DXHX01XA	S16DHA		X		**X**		*	*	*	*	*	*
		I	71MS16DXIX01XA	S16DIA		X		**X**		*	*	*	*	*	*
		J	71MS16DXJX01XA	S16DJA		X		**X**		*	*	*	*	*	*
		K	71MS16DXKX01XA	S16DKA		X		**X**		*	*	*	*	*	*
		L	71MS16DXLX01XA	S16DLA		X		**X**		*	*	*	*	*	*
		M	71MS16DXMX01XA	S16DMA		X		**X**		*	*	*	*	*	*
12	MW19	A(0-6")	71MS19DXAX01XA	S19DAA		**X**		**X**		**X**	**X**	**X**	**X**	**X**	**X**
		B(18-24")	71MS19DXBX01XA	S19DBA		@		@		@	@	@	@	@	@
		C(10-12')	71MS19DXCX01XA	S19DCA		**X**		**X**		**X**	**X**	**X**	**X**	**X**	**X**
		D(20-22')	71MS19DXDX01XA	S19DDA		**X**		**X**		*	*	*	*	*	*
		E	71MS19DXEX01XA	S19DEA		X		**X**		*	*	*	*	*	*
		F	71MS19DXFX01XA	S19DFA		X		**X**		*	*	*	*	*	*
		G	71MS19DXGX01XA	S19DGA		X		**X**		*	*	*	*	*	*
		H	71MS19DXHX01XA	S19DHA		X		**X**		*	*	*	*	*	*
		I	71MS19DXIX01XA	S19DIA		X		**X**		*	*	*	*	*	*
		J	71MS19DXJX01XA	S19DJA		X		**X**		*	*	*	*	*	*
		K	71MS19DXKX01XA	S19DKA		X		**X**		*	*	*	*	*	*
		L	71MS19DXLX01XA	S19DLA		X		**X**		*	*	*	*	*	*
		M	71MS19DXMX01XA	S19DMA		X		**X**		*	*	*	*	*	*

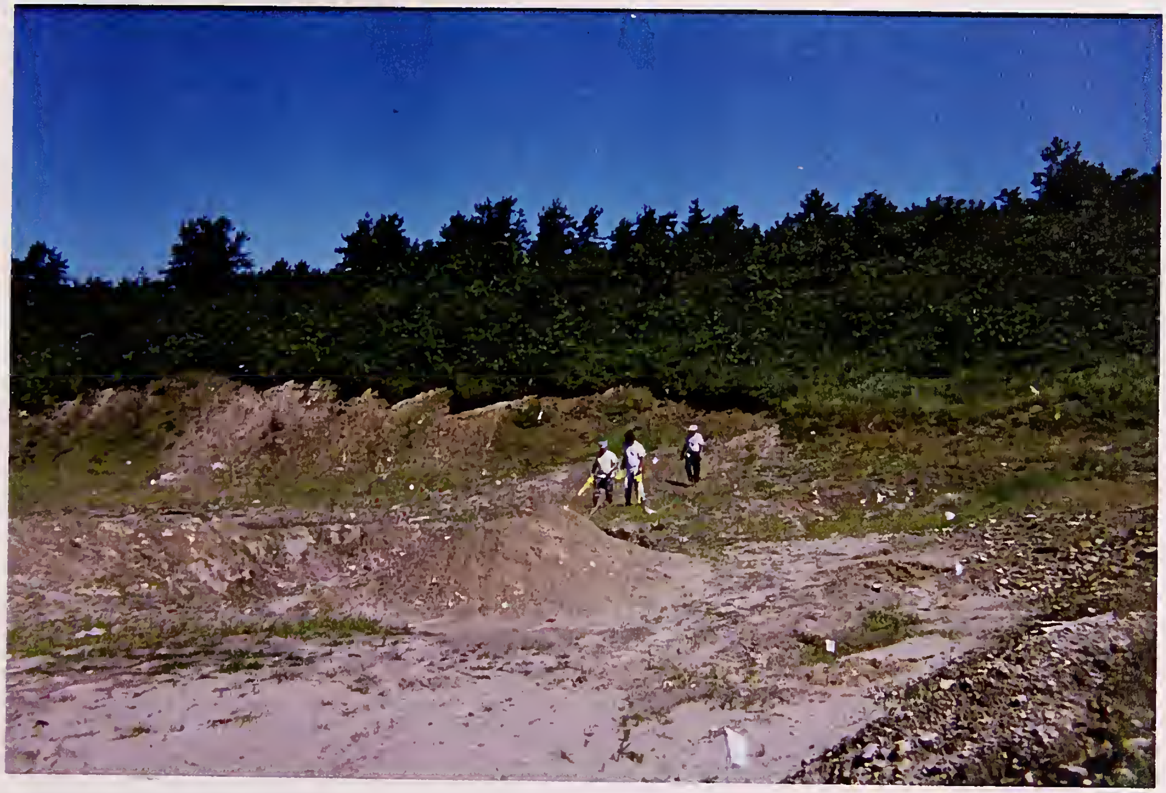
X - collect and submit

@ - to be collected after the results from the 0-6" sample are received

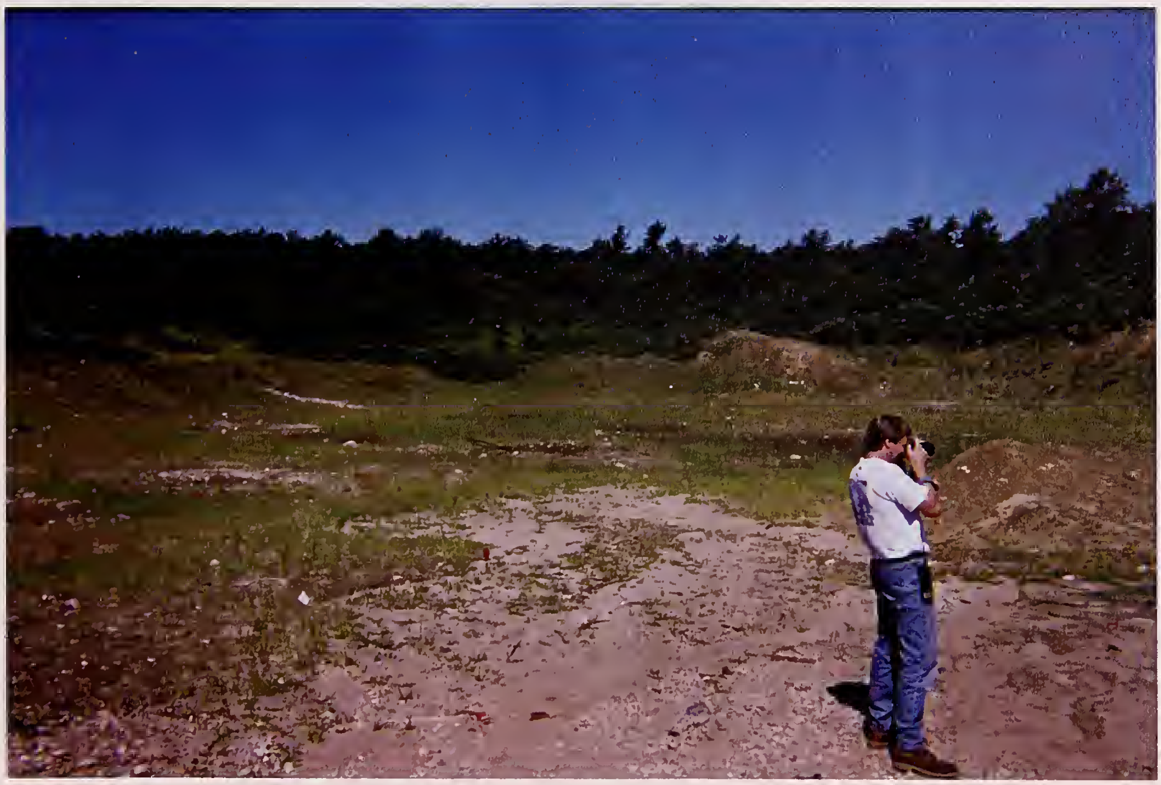
X - collect and submit ON HOLD

* - collect and submitted only if there is an FID response.

MMR Groundwater Samples from Borings					Parameters:	Explosives (screen 8330)	Explosives (EPA 8330)	Inorganics	Other Analytes:	VOC	SVOC	PCB/Pest.	Herbicide	EDB	MTBE
			MMR	EPA/Ogden	Cont:	250mL	2*1L			3*40mL	2*1L	2*1L	2*1L	3*40mL	3*40mL
Area	Loc.	Depth	ID	ID	Pres:	none	none			HCl	none	none	none	HCl	thioS
13	MW16	A	71GB16DXAX01XA	G16DAA		X				X					
		B	71GB16DXBX01XA	G16DBA		X				X					
		C	71GB16DXCX01XA	G16DCA		X				X					
		D	71GB16DXDX01XA	G16DDA		X				X					
		E	71GB16DXEX01XA	G16DEA		X				X					
		F	71GB16DXFX01XA	G16DFA		X				X					
		G	71GB16DXGX01XA	G16DGA		X				X					
		H	71GB16DXHX01XA	G16DHA		X				X					
		I	71GB16DXIX01XA	G16DIA		X				X					
		J	71GB16DXJX01XA	G16DJA		X				X					
		K	71GB16DXKX01XA	G16DKA		X				X					
		L	71GB16DXLX01XA	G16DLA		X				X					
		M	71GB16DXMX01XA	G16DMA		X				X					
		N	71GB16DXNX01XA	G16DNA		X				X					
		O	71GB16DXOX01XA	G16DOA		X				X					
12	MW19	A	71GB19DXAX01XA	G19DAA		X				X					
		B	71GB19DXBX01XA	G19DBA		X				X					
		C	71GB19DXCX01XA	G19DCA		X				X					
		D	71GB19DXDX01XA	G19DDA		X				X					
		E	71GB19DXEX01XA	G19DEA		X				X					
		F	71GB19DXFX01XA	G19DFA		X				X					
		G	71GB19DXGX01XA	G19DGA		X				X					
		H	71GB19DXHX01XA	G19DHA		X				X					
		I	71GB19DXIX01XA	G19DIA		X				X					
		J	71GB19DXJX01XA	G19DJA		X				X					
		K	71GB19DXKX01XA	G19DKA		X				X					
		L	71GB19DXLX01XA	G19DLA		X				X					
		M	71GB19DXMX01XA	G19DMA		X				X					
		N	71GB19DXNX01XA	G19DNA		X				X					
		O	71GB19DXOX01XA	G19DOA		X				X					



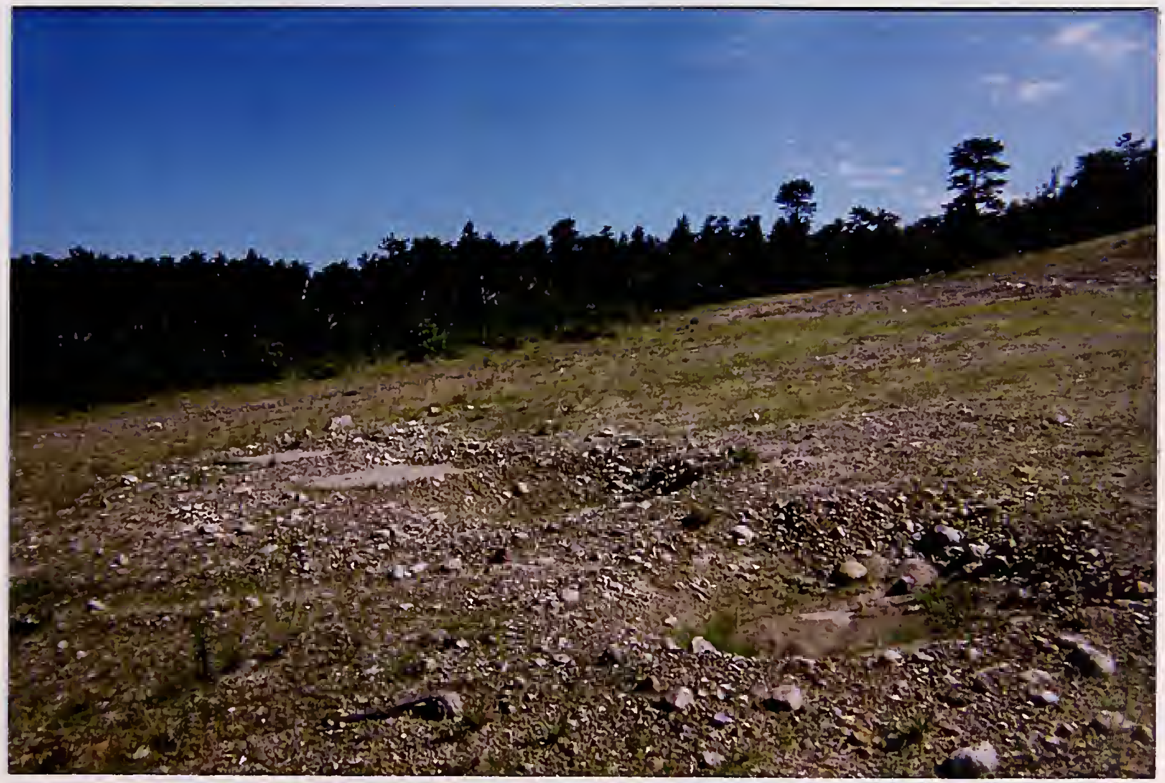
Photograph A: Demo Area 1, facing north in topographic low



Photograph B: Demo Area 1, facing west across drill pad in topographic low

Photograph C: Demo Area 2, facing west toward topographic low

Photograph D: Demo Area 2, facing northeast toward the graded hill and the bunker



Photograph E: Demo Area 2, facing northeast toward the four demolition craters on the graded hill

ATTACHMENT A: FIELD GUIDE TO HIGH EXPLOSIVES

Any substance encountered during sampling activities which differs in any way from natural media will be treated as a dangerous substance, carefully removed from the sample, and set aside.

EXPLOSIVES

NAME	DESCRIPTION	REMARKS
BLACK POWDER	BROWN TO BLACK	MANUFACTURED IN GRAINS THAT RANGE IN SIZE FROM SMALLER THAN SALT GRAINS TO GRAINS AS LARGE AS SMALL PEBBLES. HIGHLY SENSITIVE TO IGNITION BY HEAT, FRICTION. FLAME, SPARK. WHEN WET, IT IS CORROSIVE TO MOST METALS.
TNT	LIGHT YELLOW TO BROWN OR GRAY	LIGHTLY CORROSIVE WITH LEAD. USED IN BOMBS, GRENADES, DEMOLITION CHARGES, PROJECTILES. EXUDES AT ELEVATED TEMPERATURES. MODERATELY TOXIC BY SKIN ABSORPTION OR INHALATION.
EXPLOSIVE D	BRIGHT YELLOW TO ORANGE. ALSO CALLED AMMONIUM PICRATE.	RELATIVELY INSENSITIVE. HIGHLY TOXIC BY INHALATION, INGESTION, OR SKIN ABSORPTION
AMATOL	LIGHT BROWN TO YELLOW/MIXTURE OF TNT AND EXPLOSIVE D	SLIGHT HYGROSCOPIC. HAS CORROSIVE EFFECTS ON COPPER, BRONZE, LEAD, BRASS. HIGHLY TOXIC BY INHALATION, SKIN CONTACT, INGESTION.
COMPOSITION B	WHITE TO BROWNISH YELLOW, MIXTURE OF TNT AND EXPLOSIVE D	SLIGHTLY CORRODES COPPER, BRASS, CADMIUM, ZINC. USED IN BOMBS, PROJECTILES, GRENADES, SHAPED CHARGES.
OCTOL	LIGHT BROWN	USED IN BOMBS, PROJECTILES, SHAPED CHARGES.
RDX	WHITE. ALSO CALLED CYCLONITE	SENSITIVE TO IMPACT AND FRICTION.SLIGHTLY CORROSIVE WITH COPPER, BRASS, MILD STEEL, CADMIUM. MODERATELY TOXIC BY INHALATION OR INGESTION.
HMX	WHITE. ALSO CALLED OCTOGEN	SENSITIVE TO IMPACT AND FRICTION. SLIGHTLY TOXIC.
PETN	WHITE	SENSITIVE TO IMPACT. SLIGHTLY CORROSIVE TO BRASS, CADMIUM, ZINC. VERY SLIGHTLY TOXIC.

EXPLOSIVES, continued

NAME	DESCRIPTION	REMARKS
LEAD AZIDE	WHITE TO LIGHT BROWN	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO COPPER, ZINC. VERY SLIGHTLY TOXIC.
LEAD STYPHNATE	LIGHT ORANGE TO REDDISH BROWN	SAME AS LEAD AZIDE.
MERCURY FULMINATE	GRAYISH	VERY SENSITIVE TO IMPACT, FRICTION, SPARKS. CORROSIVE TO ALUMINUM, MAGNESIUM, BRONZE, COPPER, ZINC, BRASS. HIGHLY TOXIC THROUGH SKIN ABSORPTION, INHALATION, INGESTION. SYMPTOMS RESEMBLE MERCURY POISONING.

PYROTECHNIC AGENTS USED AT MMR

SYMBOL	COMMON NAME	VISUAL IDENTIFICATION	ACTION
CS	NONE	WHITE CRYSTALLINE SOLID	TEAR AGENT
HC	HEXACHOROETHANE	WHITE SOLID	SCREENING SMOKE
WP	WHITE PHOSPHOROUS	PALE YELLOW SOLID	SCREEN SMOKE AND INCENDIARY
RP	RED PHOSPHOROUS	REDDISH BROWN POWDER	SCREENING SMOKE

OTHER COMPOUNDS

NAME	PROPERTIES	STABILITY
Picric Acid	lemon-yellow crystalline solid	very sensitive to blows or friction
Tetryl	fine yellow crystalline powder	sensitive to blows or friction
Composition A	unknown	unknown
Composition C3	unknown	unknown
Composition C4	unknown	unknown
Pentolite (50/50)	unknown	unknown
Tracer Compound	unknown	unknown
PBX	unknown	unknown
Ednatol	unknown	unknown
Tetrytol	unknown	unknown

FS-12 PROJECT DESIGN REPORT UPDATE

November 1, 1997

The FS-12 Draft Design Report was prepared to address the design basis to complete the engineering and design of the extraction, treatment, reinjection (ETR) system for the containment of the FS-12 (Fuel Spill 12) plume. This document was issued for comment 20 October 1996 using the most current information and data available at that time. Comments on the document were received, responded to and resolved with the regulators, TRET and JPAT members and other stakeholders. Attachment 1 lists the comments/responses/resolutions.

This update is intended to provide the necessary background to bridge the period between the drafting of the Draft Design Report and the final design used for construction. It will also serve as the vehicle that will close the document review process and result in the Draft Design Report becoming final.

The process unit operation of the system remains the same as described in the Draft Design Report with the groundwater being extracted from the aquifer to the influent tank, pH adjustment, followed by greensand filtration, UV Oxidation, granulated carbon filtration and reinjection to the aquifer. The system's nominal operational rate is 850 gpm as previously reported.

Since the publication of the Draft Design Report in October 1996, several changes have been made to the plume definition and to the extraction and reinjection wellfield as a result of a pre-construction investigation program. Value engineering resulted in changes to the control philosophy for operations.

The Draft Design Report had 30 extraction and 30 reinjection wells I the design. Through additional data collection, modeling, and value engineering the installed wellfield configuration is 25 extraction wells and 23 reinjection wells. The current well configuration is shown in Figure 1, attached. To meet Massachusetts fire regulations the chemical storage tanks, hydrogen peroxide, sodium hydroxide and potassium permanganate were moved outside the treatment building. Fire detection and interfacing with the base wide fire alarm system resulted in additional hardware and software to the instrumentation/control system.

Supporting documents that are referred to within the text of the Draft Design Report have been written. These include the Draft Execution Plan, Performance Monitoring Plan (PME) and the Technical Memorandum - FS-12 Modeling Report.

Upon completion of the as-built drawings, the Piping & Instrumentation Drawings (P&IDs) will be forwarded to each holder of the Draft Design Report for their information. The P&IDs are the final design basis for the operating ETR system.

Memorandum of Resolution
Responses to Comments on the FS-12 Plume Containment System Draft Design Report

Responses to P. Marchessault (USEPA) Comments dated November 5, 1996

General Comments

1. Although provisions for iron and manganese control are provided at the treatment facility, the potential for iron clogging (or iron bacterial slime growth) within the extraction wells, collection header and influent piping system must be evaluated and presented. Alternatives for addressing this issue, should it become problematic, must be identified now so that provisions for control of management can be incorporated in the system design.

   Response: Plugging of the extraction wells and extraction piping with iron deposits and/or biological slime is a significant concern for the FS-12 plume because of the high concentrations of iron present in the concentrated portion of the plume - the wells in the toe of the plume are in areas with a high dissolved oxygen content and thus should have very low iron concentrations. Methods are available to control iron buildup in extraction headers: periodic pigging of the lines, periodic acid washing, magnetic inserts that orient the iron particles to reduce sticking, and the addition of sequestering agents. However, the only known methods of controlling fouling inside the wells are: periodic shock loading with chlorine and/or acid, and oxygenation of the water near the well to precipitate the iron before it reaches the well.

   Of the 30 extraction wells at FS-12, only two or three are expected to be installed in areas with a high iron content. To better define the extent of this problem, and to allow the evaluation of alternatives, the following steps are being taken:

   - Additional monitoring wells are being sampled to better define the extent of the high iron concentrations.
   - Treatibility tests are being conducted on drums of water collected from monitoring well GMW-20, which is known to contain high concentrations of iron.
   - Vendors with technology for oxygenating groundwater to precipitate iron, are being contacted to better define the costs and limitations of the technology.
   - Each extraction well will be sampled for iron during installation to provide early information on the wells that will have high iron concentrations.

   Resolution: The EPA provided the following comment regarding Jacob's response: "The findings, conclusions, and recommendations of on-going efforts to evaluate the potential for iron fouling in the collection system must be presented in the FS-12 Operations and Maintenance Manual. If periodic pigging of the lines is considered, the piping design must include cleanouts at appropriate intervals. If chemical dosing or chemical sequestering is considered, impacts on treatment plant performance and/or potential impacts on reinjection water quality must be evaluated. A chemical addition program may necessitate inclusion of additional parameters in the long term downgradient performance monitoring program. All chemical additives must be reviewed and approved prior to implementation."

   Jacobs is currently evaluating the control of iron fouling. If chemical treatment is required, it will be presented to the RPM's prior to implementation. Information will be included in either the O&M manual or the startup procedures on actions to take if iron fouling occurs. If this becomes reality after issuance of the O&M manual, information regarding chemical treatment will be provided as an attachment to the manual.

2. A formal submittal process and schedule must be established to address future modifications in the treatment system design and/or locations of extraction and injection wells as additional data and information from on-going field efforts are assimilated.

   Response: Future modifications to the treatment system design and/or locations of extraction and injection wells will be addressed at RPM meetings and presented to TRET and JPAT. Only major changes to the design philosophy will be formally submitted.

   Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

Page Specific Comments

- Comment #1, Page 1-4, §1.2, ¶2: As a point of clarification, OpTech did not initiate work on a 60 percent design. Work was initiated on a 100 percent design, and the 60 percent design was submitted in January, 1996.

  Response: The comment is noted and the text will be modified accordingly.

  Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- Comment #2, Page 1-6, §1.2, ¶1: Since this is the first time that the acronym "ROD" appears, please spell it out.

  Response: The test will be modified accordingly.

  Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- Comment #3, Page 2-4, §2.1, ¶2 and 3: The last two paragraphs of this section also appear on the previous page. Please correct as appropriate.

  Response: The test will be modified accordingly.

  Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- Comment #4, Page 2-29, §2.5.2: The baseline sampling must be performed early in the program in the event that a change to the design must be made, which would not affect the construction schedule.

  Response: As discussed in section 2.5.1, prior to system construction a plume definition data collection program will take place. This effort will include sufficient data collection activities to modify the design, as appropriate. The baseline sampling discussed in section 2.5.2 is intended only to establish baseline contaminant concentrations immediately prior to system operation to evaluate the long term performance of the FS-12 ETR system.

  Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- Comment #5, Page 2-55, §2.7.1, ¶2: The document recognizes that iron and manganese will begin to react with DO in the collection system. Options and recommendations for managing this condition with respect to future clogging must be presented.

  Response: See the response for general comment #1.

  Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- Comment #6, Page 2-57, Table 2-5: The Massachusetts MCL for EDB is 0.02 ug/l, while the EPA MCL is 0.05 ug/l. Please correct.

  Response: The table will be corrected to reflect that the Massachusetts MCL for EDB is 0.02 µg/l.

  Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- Comment #7, Page 2-61, §2.83: The Draft Performance Monitoring Plan must be capable of demonstrating that the containment system is functioning properly at startup (or can be optimized); will not have a significant adverse impact on the ecology of Snake Pond; and will satisfy the overall cleanup objectives. Design of an appropriate performance monitoring program should not be considered a potential design limitation. The hydraulic monitoring elements of the plan must be designed to reflect and monitor the anticipated hydraulic response of the system.

  Response: As discussed in the text of Section 2.8.3, details regarding performance monitoring will be submitted under separate cover. An important component of this plan will include hydraulic monitoring. However, as discussed in Section 2.8.3, all stakeholders must recognize that the objective of minimal hydraulic impact will increase the complexity and cost of performance monitoring.

  Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

- Comment #8, Page 3-7, §3.1.6, ¶3: Additional details regarding use of NaOCl as a biocide must be provided. Please include the following:

  1. Projected dosage for "shock" loading and continuous feed chlorination together with advantages and disadvantages associated with each control strategy.

  2. Treatment location/frequency (i.e., will all wells be treated simultaneously and on a regular schedule or will individual wells be treated as necessary).

  3. A summary of operational experience associated with use of chlorination to mitigate against potential of clogging of reinjection wells.

  4. Criteria to be used to establish dosing schedule and frequency.

  5. Options available to monitor residual chlorine compounds within aquifer.

Response: Facilities have been provided to allow the addition of hypochlorite to the water leaving the treatment system, if needed to control generalized biological fouling. Chlorine is not stable in the environment, it reacts with any organic material present and converts to the chloride. So, the chlorine should not migrate any significant distance from the reinjection wells. However, a literature search did not reveal any definitive information on the migration of free chlorine, so the addition of hypochlorite will be used with caution. The following is the response to specific sub-comments:

1. The projected continuous dosage is specified as 2 mg/l free chlorine. This dosage will be used if an increase in pressure drop at the reinjection wells indicates that biological fouling is occurring in all the wells. "Shock" loading if required will be conducted using standard procedures for disinfecting water wells. Shock loading would be conducted at individual wells as part of any required redevelopment of the wells, and would only be conducted if severe fouling occurs at any of the wells. The shock loading would be accompanied by jetting, or some other physical form of forcing the chlorine into the formation, and may also be accompanied by acid washing to dissolved any precipitated inorganics.

2. If continuous injection is used, the hypochlorite will be added to the water leaving the treatment system. If shock loading is required, it will be performed at the individual wells.

3. A literature search did not reveal any experience with the continuous use of chlorine to control fouling in reinjection wells. The 2 mg/l dosage rate was based on standard guidelines for disinfecting potable water and wastewater, plus was based on conversations with Betz, a major supplier of hypochlorite. Shock loading is a common approach to controlling the bacteria growth in water wells. "Groundwater Technology", by Fletcher G. Driscoll provides information on standard shock loading procedures, using free chlorine concentrations in the 500 mg/l to 2000 mg/l range. The book provides examples of satisfactory performance using this shock loading combined with other activities such as "jetting" to agitate the formation, and acid washing to remove any inorganics precipitated by the bacteria.

4. Plugging of the reinjection wells will be monitored by the level in the wells and by the wellhead pressure. The first indication of plugging will be a rise in the level in the wells. The second indication will be an increase in pressure - the system is designed to provide up to 25 psig pressure, at the wells, to help force the water into the formation. Increases in level and/or pressure will be plotted to provide information on when the plugging will begin to impact capacity.

5. If hypochlorite is added on a continuous basis, downstream monitoring wells will be sampled to insure that free chlorine is not migrating from the site. After shock loading, the chlorinated water can be removed from the wells, following the standard procedures for chlorinating wells, so long term monitoring would not be required.

Resolution: The EPA provided the following comment regarding Jacob's response: "Use of a free chlorine concentration of 2 mg/l on a continuous basis appears excessive, possibly by an order of magnitude. Further research and analysis of methods for the control of biofouling in reinjection wells at FS-12 is clearly needed. Given the absence of data regarding continuous injection of chlorine for this purpose, pilot scale testing during system start up should be considered. The suitability of using water treatment and/or wastewater disinfection criteria to establish continuous chlorine dosage in reinjection wells has not been demonstrated. Pilot testing would enable an evaluation of appropriate dosage requirements. Use of a periodic, but intermittent dosing program (i.e., 1 hour per day or 1 day per month) should also be considered."

Jacobs established the design basis of 2 mg/l based on recommendations from Betz Corporation, the supplier of water treating chemicals at Otis, and on the Massachusetts DEP guidelines of maintaining 2 mg/l residual chlorine in drinking water supplies.

Since the original design basis was developed, we have obtained additional information that indicates that 0.2 to 0.5 mg/l may be better concentrations for reinjection water. Sources of this information are:

- "Aquatic Microbiology" by F. A. Skinner and J. M. Shewan (page247)
- "Troubleshooting - Stopping Iron Bacteria at its Source", in the Canadian Water Well, June 1989 (p8)
- "Controlling Microorganisms in Cooling Water Systems". Chemical Engineering, October 31, 1983 (pp 75-77).

Our program during operation of the reinjection system will be to monitor fouling of the reinjection wells, as indicated by an increase in the water level in the wells. If fouling is occurring, then hypochlorite will be added to the water to maintain a free chlorine concentration in the 0.2 to 0.5 mg/l range. The levels in the wells will continue to be monitored to determine if fouling is still occurring. The monitoring wells will also be sampled to determine if chlorine is migrating off-site. Based on this monitoring, chlorine concentrations may be adjusted, either up or down, to minimize fouling and/or the migration of chlorine.

If addition of chlorine is required to prevent fouling, the procedures and dosages will be presented to the TRET, prior to implementation.

- **Comment #9, Page 3.16, §3.2.2, ¶2:** The proposed disposal method, monitoring program and location for residuals management disposal must be established and approved. This must include handling and management for residual streams that do not fail TCLP criteria (i.e., how filter backwash will be monitored and disposed).

  Response: Sediment from the backwash and treatment operation will be collected in the sedimentation tank and will be analyzed to determine proper disposal. If sediments are hazardous they will be disposed of at a hazardous disposal facility. If sediments are non-hazardous, it will be disposed of at a non-hazardous disposal facility.

  Resolution: As per the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the EPA found the response satisfactory, with no need for additional modifications.

Responses to L. Pinaud (MADEP) Comments dated November 8, 1996

General Comments

1. Model Representativeness:

Efforts to date have failed to develop a flow model of the aquifer in the FS-12 area which creates a plume configuration that mirrors the actual contaminant plume.

Initial attempts to recreate the actual plume configuration involved seeding the model with particles representing a release of contaminants at the source. The model was then run for the estimated time it would have taken for the actual plume to have established its current dimensions.

This model run indicated that the bulk of the plume particles discharge to Snake Pond.

Field data does not confirm this situation. In an attempt to better represent field conditions, particles were distributed in the widespread pattern that mimics the actual plume, rather than seeking to recreate the plume by seeding the source, as was done initially. However, when this second version of the model was run, it also indicated that the bulk of the plume particles discharged to Snake Pond.

Therefore, because field data conflicts with the model behavior, predictive runs of the current ETR design may not accurately represent the percent of the plume capture. This is because the ETR system has been designed to capture the modeled plume rather than the actual plume.

The Department recommends using particle tracking rather than numerical modeling techniques to evaluate plume capture in all plume areas.

Response: AFCEE agrees that there are uncertainties in the ability of the FRAC3DVS model to simulate migration of the FS-12 plume. Simulating the transport of contaminants is considerably more complex than groundwater flow modeling. However, including more particle tracking simulations, flow net analysis, or analytical simulations at the present time would not improve the level of confidence in the design basis for the FS-12 ETR system or lend additional insight into the behavior of the FS-12 plume. The primary difficulty in reproducing the behavior of the FS-12 plume is due to uncertainties in the site conceptual model. Some of these uncertainties may never be resolved. For instance the concentration, extent, and volume of the source area, the presence of preferential flow paths in the groundwater flow system, and historical shifts in the location of the groundwater mound near the FS-12 plume, are all factors that could have a pronounced effect on the movement of the FS-12 plume but cannot be quantified with certainty. In addition, none of these factors could be accounted for by performing flow net analysis or analytical simulations.

To the degree possible, AFCEE is attempting to address data gaps before system construction by performing additional pre-design data gap activities, including chemical and hydraulic monitoring to assess interactions between groundwater and Snake Pond, a groundwater screening program to refine the nature and extent of the FS-12 plume, and geotechnical borings to better define the site stratigraphy. As this information becomes available, additional particle tracking runs will be performed and presented to all stakeholders for review and approval. However, it may never be possible to reproduce the current plume configuration due to the unknowns concerning the plume source area and the natural complexities that characterize any groundwater flow system. In addition, it should be recognized that even if the FS-12 model was able to reproduce the FS-12 plume it would not ensure that the design basis for the FS-12 extraction would be more accurate. It is likely that many variations of boundary conditions, and hydraulic parameters could produce the FS-12 plume within the same level of accuracy Instead, to compensate for uncertainties in the site conceptual model, the FS-

12 ETR system includes flexibility in operating flow rates, and the type and concentration of contaminants that the treatment system can handle.

Resolution: Pursuant to the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the response will be modified as follows:

The FS-12 plume configuration has been updated to mirror the actual contaminant plume, based on the most recent analytical data. Recent modeling simulations are capturing 99.9+% of the plume mass and about 99% of the plume volume. A small number of particles which are being lost to the system are currently being evaluated to determine 3-D details of their particle paths and implications for system performance monitoring and indicators of possible system failure.

We believe that the modeling effort achieves the objectives as outlined in the existing modeling report (ECE, 1996), including maximizing capture while minimizing disturbance of the system (e.g. flux into Snake Pond, disturbance of the J. Braden Thompson Plume). In addition, the basis of design has not been changed significantly from the assumptions discussed at the TRET, JPAT, and other meetings last fall. Based on updated definition of the extent of plume distribution, we are locally modifying the final configuration of the operating ETR system.

In order to provide the MADEP and other interested stakeholders with an appropriate level of understanding of the above information, we have assembled a package of summary information from the modeling runs at FS-12, including:

- Background and history of groundwater modeling at FS-12
- Review of the basis of design and recent field results
- Details of the old model (DSM II) under ambient and pumping conditions, including:
    - Water level, drawdown and mounding, and particle track maps
    - Flow nets from representative model layers in map view and cross section
    - Tabulation of assumptions used in modeling simulations
- Details of the revised stratigraphy under ambient and pumping conditions, including:
    - Water level, drawdown and mounding, and particle track maps
    - Flow nets from representative model layers in map view and cross section
    - Tabulation of assumptions used in modeling simulations
- Maps showing fluxes in/out of Snake Pond

The package will be available on February 28, 1997 for the TRET to review.

2. **Design Effectiveness:**

a. A complete review and evaluation of the basis for design effectiveness requires that particle track analyses and areal and vertical flow nets must be presented. Neither are available in the report. Please include.

b. Justification for the selection of the elevations of the screened intervals for the injection and extraction wells should be presented. Specifically, please justify why:

1. Reinjection and extraction are not at the same depth.

2. Extraction wells are not screened across the full height of the contaminated aquifer.

3. Reinjection is proposed along the western flank of the plume but reinjection of treated groundwater along the eastern flank of the plume is not proposed.

c. Please justify the pumping rates for the axial extraction wells.

Response:

a. AFCEE is currently performing a variety of data gap activities that will be used to refine the design basis of the FS-12 ETR system, as necessary. Following data gap collection activities, additional particle tracking runs will be presented to all stakeholders. Final particle track analyses and areal and vertical flow nets showing the extent of plume capture will be presented under separate cover for review and approval at that time.

b.

1. The toe reinjection well screens are located at the same depth as the extraction well screens. As stated in the Draft Design Report, the north and central reinjection wells are located at a depth predicted by the groundwater flow model that minimized circulation of reinjected water to the extraction wells and enhanced plume capture.

2. Toe extraction wells are screened across the full thickness of the contaminated portion of the aquifer at the toe of the FS-12 plume. The axial extraction wells are not screened across the full thickness of the FS-12 plume in the more concentrated plume section to maximize capture of the most highly contaminated portion of the plume.

3. Reinjection wells along the western plume flank are designed to minimize hydraulic impacts to Snake Pond in response to ecological concerns regarding the FS-12 ETR system. Three toe reinjection wells are located along the southeastern flank of the plume. However, additional eastern reinjection wells provide no ecological benefit and are not required to enhance capture of the FS-12 plume.

c. Pumping rates for the axial extraction wells were iteratively selected by performing multiple modeling runs with the objective of achieving maximum plume capture of the most concentrated portion of the plume. However, it should be recognized that pumping rates for all extraction wells will be adjusted as necessary during performance monitoring to meet project objectives.

Resolution:

a. Pursuant to the February 5, 1997 FS-12 Draft Design Report comment resolution meeting, the response will be modified as follows:

AFCEE is currently performing a variety of data gap activities that will be used to refine the design basis of the FS-12 ETR system, as necessary. Following data gap collection activities, additional particle tracking runs will be presented to all stakeholders. Please note the response to general comment 1, above, including the providing of particle track analyses. The use of areal and vertical flow nets would not be expected to provide additional value to the above package.

b. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

c. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

3. Data Summary and Evaluation:

The summary and evaluation of the FS-12 data should tabulate and map groundwater analytical results from both the screened hollow stem auger data set as well as from monitoring wells (identify and justify the exclusion of confirmed or suspected false data and flag those data locations that fail to explore the full height of the plume). The Report does not contain such a data summary and evaluation. Instead , the Report refers the reviewer to a report entitled "Plume Containment Design Data Gap Field Work Technical Memorandum: Operational Technologies Corporation." dated

February, 1996. This Technical Memorandum also fails to evaluated the data. Please provide the requested data summary and evaluation.

Response: Data tabulation and an analysis of data quality are beyond the scope of the FS-12 Design Report. As stated previously, data gap activities at FS-12 are currently ongoing. Following completion of data gap activities a summary and evaluation of FS-12 data will be presented under separate cover.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

4. Treatment:

The residence time designed for each carbon bed is 15 minutes. This contact time is based on three carbon vendors' recommendations (7.5 minutes for each bed (page 3-31, last paragraph)) and it is also based on a test conducted in Florida on EDB contaminated groundwater (15 minutes for each bed (page 4-5, paragraph 2)). The Department agrees with 15 minutes of residence time for each carbon bed and 30 minutes for two carbon beds in series or per train. The first carbon bed must be capable of adsorbing all contaminants, the second bed is used for polishing and assurance.

The proposed three parallel carbon train system (two carbon beds per train) satisfies the aforementioned residence time under normal conditions. However, during a carbon bed change, one train will be out of service and the entire flow will be handled by the remaining two trains. Consequently, the residence time for each bed will be reduced to 10 minutes (page 4-5, paragraph 4). This arrangement violates the aforementioned design philosophy and offers very limited assurance. Therefore, the Department recommends that an additional carbon train (two 20,000 pound carbon beds in series) be installed to ensure 15 minutes of residence time for each bed at all times.

Response: We disagree with the need to design the carbon beds for a minimum residence time of 15 minutes based on the following information that was presented in Section 3.3.1 of the Design Report and based on information contained in Appendix B to Volume 1 of the Design Report:

- The pilot tests demonstrated that both benzene and EDB concentrations could be treated to non-detect concentrations using an empty bed contact time of 4.5 minutes.
- Calgon recommended a residence time of 7.5 to 10 minutes.
- A minimum 10 minute residence time was chosen based on the above information and based on additional information listed below.
- To insure a minimum 10 minute residence time during replacement of the carbon, and extra carbon train was specified (a third train). An additional advantage of the third train was information from EDB studies in Florida which indicated that the longer residence time would provide a more efficient utilization of the carbon.

Additional information contained in Appendix B but not summarized in Section 3.3.1 includes:

- More than 1000 homes, with EDB contaminated water in Florida, were provided with activated carbon treatment systems. The carbon treatment systems used had residence times ranging from 2.5 to 5 minutes.
- Carbon treatment systems were installed on nine public water supplies. The residence time in these carbon systems ranged from 5 to 12 minutes.
- The longer residence times in the public water supply systems were used to increase carbon usage efficiency.

As is demonstrated by the above information, a design residence time of as low as 5 minutes will effectively remove the contaminants, but a design residence time of 10 minutes was used instead to be conservative.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

Page Specific Comments

- **Comment #1:** Please provide definition keys for all acronyms and abbreviations.

  Response: The text will be modified accordingly.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #2, Page 2-6, Figure 2-2:** Please change EDB to benzene.

  Response: The changes will be made to the text.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #3, Page 2-30, Table 2-3:** The Department recommends the baseline sampling plan be expanded. The following wells should be added to the baseline sampling program:

  GMW-5
  GMW-15
  GMW-19
  GWM-36
  GMW-38
  GMW-47
  GMW-49
  GMW-50
  GMW-54 and
  GMW-59 (all levels)

  Response: As discussed in Section 2.5.2 , a more comprehensive round of groundwater sampling will take place prior to system startup. The details of this comprehensive "baseline" groundwater sampling round will provided in the performance monitoring plan to be provided under separate cover. The DEP recommended wells GMW-5, GMW-15, GMW-19, GMW-36, GMW-38, GMW-47, GMW-49, GMW-50, GMW-54, and GMW-59 will be included in this comprehensive sampling round.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #4, Page 2-35, Paragraph 3:** Ecological monitoring is a component of the system performance monitoring. Please indicate when the Ecological Sampling Plan and schedule will be submitted for review.

  Response: The draft Workplan for the Ecological Assessment Associated with Groundwater Plumes and Remedial Activities at MMR was submitted for review on 27 January, 1997. The draft Ecological Sampling and Analysis Plan for FS-12 is scheduled for submission on 21 March, 1997.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- Comment #5, Page 2-35, Paragraph 4: The text stated that "it may be necessary to slightly modify the FS-12 ETR network...to hydraulic impact on the pond...the system will be started slowly to allow monitoring on the pond". Please elaborate on the performance monitoring procedure planned for start-up of the ETR system.

  Response: As discussed in the text of Section 2.8.3, details regarding performance monitoring will be submitted under separate cover. A discussion of system startup procedures will be included in the operations and maintenance manuals.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- Comment #6, Page 2-40, Paragraph 1: Since Snake Pond is potentially impacted by the FS-12 ETR system, please add 310 CMR 4.00 (Surface Water Regulations) to AFCEE's list of ARARs.

  Response: Note: the correct reference appears to be 314 CMR 4.00, "Massachusetts Surface Water Quality Standards. We agree that 314 CMR 4.00 is an ARAR for the FS-12 Plume Containment Project. The plume containment project meets the requirements of the ARAR as follows:

  Based on Figure 31 in 314 CMR 4.00, the waters in Snake Pond are listed as " Inland Waters, Class B". The discharge from the FS-12 treatment system will meet the Class B requirements as follows:

  - Hydrogen peroxide is being added to the discharged water to raise the dissolved oxygen content to approximately 8 mg/l. this exceeds the discharge requirement of 5 mg/l for warm water fisheries or the 6 mg/l for cold water fisheries.
  - The discharge temperature will be lower than 68°F. The average groundwater temperature is approximately 55°F with an expected 2.2°F temperature rise across the treatment system.
  - The discharge water will either be at the pH of the natural water or will be neutralized to between 6.5 and 8.3.
  - The treatment system will not add fecal coliform. Instead, the UV/peroxide system being installed will reduce the concentration of any fecal coliform that are present in the extracted groundwater.
  - The treated water will pass through filters and thus will be free from floating, suspended, and settleable solids and from oil and grease.
  - Iron and manganese will be removed from the water, which will reduce the color and turbidity of the water.
  - No compounds which add a taste or odor will be added to the water.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- Comment #7, Page 2-45, Paragraph 4: While AFCEE is expected to meet state permit requirements as performance standards for the discharge of treated groundwater to the ground, a permit is not required.

  Response: We agree that a permit is not required but the discharge from the treatment facility must meet the Commonwealth discharge requirements.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #8, Page 2-54, Table:** Please correct a typographical error for contaminant concentration in the "Hot Spot" column.

  Response: The concentration of benzene in the hot spot will be changed to 1.167 micrograms/liter.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

- **Comment #9, Page 2-57, Table 2-5:**
  a. Please provide specific analytical reference (i.e. 502.1, 502.2 or 524.2) for each Contaminant of Concern (COC).

  b. The concept of a Practical Quantification Limit (PQL) is usually associated with wastewater analysis. Method Detection Limits (MDLs) for various analyses are experimentally determined using various analytical standards prepared with reagent grade water and do not account for the matrix effects routinely encountered in wastewater analysis. For standard drinking water analysis PQLs and MDLs are in most cases the same value because of the absence of matrix effects. If a matrix effect is suspected, a PQL can be determined experimentally utilizing standard addition techniques. Please replace estimated PQLs with MDLs.

  c. The MDL for EDB using EPA Methods 504 is 0.010 ug/l (ppb). Therefore, the cleanup level for EDB should be below 0.010 ug/l.

  d. Cleanup Levels for all organic contaminants in groundwater should be non-detect (ND).

  e. Contract Required Quantification Limits (CRQL) for USEPA contract laboratories have no relevance for the analysis of groundwater to determine compliance with drinking water standards. Please remove the CRQL column.

  f. Please indicate that the MCLs reflect the more stringent of the Federal or Massachusetts MCLs (MMCLs). For example: the MMCL for EDB is 0.02 ug/l (micrograms per liter), which is more stringent than the Federal MCL of 0.05 ug/l.

  g. The Cleanup Level for Iron should be changed to 0.07 ug/l.

  Response:
  a. The text will be modified to provide specific analytical reference.

  b. The text will be modified as appropriate.

  c. The design base for the treatment of EDB in the extracted groundwater is treatment to non-detect.

  d. The design basis for treatment of all the organic compounds listed in Table 2-5 is treatment to non-detect. However, in other plumes at the site, organic compounds may be present that are non-toxic (high MCLs or no MCLs) and that are not readily amenable to treatment. If non-toxic organic compounds are detected during the evaluation of the other plumes at the facility, treatment levels for those compounds will be determined on a case by case basis.

  e. The text will be modified as appropriate.

f. The MCL for EDB will be revised, and footnoted, to reflect the lower Massachusetts MCL of 0.02 microgram/l.

g. Treatment to an iron concentration of 0.07 µg/l is not feasible using the proposed treatment system. Discussions with the vendors of the Greensand filters indicate that it should be possible to remove 90% of the iron, which is the basis for our design basis treatment concentration of 53 µg/l, however there is no requirement for the removal of iron other than the need to reduce the iron concentration as a pretreatment step upstream of the carbon filters. Iron and manganese are both naturally occurring in the groundwater in the region so the only discharge requirement should be the requirements of 314 CMR 5.00 (Groundwater Discharge Permit Program) which list the maximum allowable iron concentration of 300 µg/l and the maximum manganese concentration of 50 µg/l. The cleanup levels for iron and manganese listed in Table 2-5 are typographical errors. The correct cleanup levels for these two compounds should be listed as 300 µg/l and 50 µg/l respectively.

Resolution:

a. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

b. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

c. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

d. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

e. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

f. As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

g. As discussed in the February 5, 1997 FS-12 Design Report comment resolution meeting, the clean up level for iron is not 0.07 µg/L, as stated in the comment. There is not a clean up level for iron and manganese in effluent water that is reinjected to the ground. The treated water can be injected at levels equal to the groundwater's naturally occurring background concentrations of iron and manganese.

As stated on pages 3-14 and 3-15 of the design report, a portion of the effluent water will be used in the treatment building (ie. toilets, safety showers, eye wash stations) and must meet potable water standards. This water will be sampled and analyzed to confirm that it is in compliance with the Massachusetts drinking water standards for iron and manganese of 300 ppb and 50 ppb, respectively.

- Comment #10, Page 3-15, Paragraph 1: Please add USEPA method 502 or 524 to the first bullet.

  Response: The text will be modified as appropriate.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, the DEP found the response satisfactory, with no need for additional modifications.

Responses to D. Hill (Bregman & Company, Inc.) Comments dated November 1, 1996

- Comment #1, Section 2.4.2 (Well Locations), pg. 2-17, paragraph 2: Please illustrate the need for additional investigation to determine placement of southern reinjection fence by locating the J.B.T source area on the figures.

  Response: Section 2.5.1 provides a discussion of pre-construction data collection activities, including groundwater sampling during extraction/reinjection well installation. Based on a review of available information several source areas may be associated with the J.B.T. plume. However, to clarify, the potential source areas located closest to the reinjection wells will be provided on Figure 2-3.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- Comment #2, Section 2.4.3 (Screen Locations), pg. 2-18, paragraph 2: How do the selected well screen depths minimize recirculation of reinjected water?

  Response: To determine the percentage of recirculated water, particle tracking was performed. Based on the modeling efforts, the proposed screen placements minimized the recirculation of treated water.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- Comment#3, Section 2.4.3 (Screen Locations), Figure 2-5, pg. 2-20: There is no 0.02 ppb contour on this figure.

  Response: Isocontours will be added to Figure 2-5.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- Comment #4, Section 2.4.6 (Additional Modeling Efforts), pg. 2-22: Have the hydraulics of recirculating wells (in conjunction with the FS-12 above-ground treatment system) been modeled? It may be worth doing some optimization runs with the model to determine if 100 % capture of the plume could be achieved (possibly even with a smaller number of wells) if water table drawdown/mounding were no longer a constraining factor.

  Response: The hydraulics of recirculating wells are being currently evaluated for several other plumes at MMR. If this technology proves promising it may be applied at other sites. During the 60 percent design effort by OpTech, 100 percent capture of the entire FS-12 plume was achieved with much fewer wells. However, the drawdown and mounding was considered unacceptable. The current extraction/reinjection well scenario is based on large number of modeling runs and additional optimization considering property access constraints in most areas is not possible.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- Comment #5, Section 2.5.5 (Ecological Data Collection), pg. 2-35, last paragraph: Please be more specific in terms of how slowly the system could be turned on.

  Response: Details regarding system startup will be provided under separate cover in the performance monitoring plan.

Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #6, Section 2.8.3 (Hydraulic Monitoring), pg. 2-60:** Specifically, how will performance monitoring be complicated by the low pumping rates?

  Response: In general, hydraulic monitoring will be complicated because changes in groundwater elevations due to operation of the FS-12 system will be small in comparison to seasonal fluctuations in the groundwater table. However, details regarding performance monitoring will be provided under separate cover in the performance monitoring plan.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #7, Section 3.1.3 (Greensand Filters), pg. 3-3, last paragraph:** Is the system designed such that no more than one of the four Greensand filter units is in the backflushing mode at any given time? If so, will the three filter units remaining in line be sufficient to handle the system flow rate without interruption?

  Response: The system is designed so that only one Greensand filter will backwash at one time. During the period when one filter is backwashing, the other three filters have the capacity to handle the entire design flow rate.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

- **Comment #8, Section 3.1.5 (Carbon Adsorption):** How long will the primary carbon adsorber last at the design influent concentrations? How long does backflushing process take and, therefore, what percentage of the time is there only one carbon adsorber in the treatment train?

  Response: Calculations indicate that replacement of a carbon bed will be required about five to nine times per year. Carbon replacement takes about three days, including the time required to order a fresh bed of carbon. During the change out period the entire train containing the replacement bed will be removed from service and the two remaining trains have the capacity to treat the entire design basis flows. Since the entire train will be removed from service during the carbon replacement period, there will be no period of time when the system operates with only one carbon bed in a train.

  Resolution: As per the February 5, 1997 FS-12 Design Report comment resolution meeting, Bregman & Company found the response satisfactory, with no need for additional modifications.

Responses to J. Dickerman (TRET Ecological Impacts Team) Comments dated November 4, 1996

- Comment #1, Page 1-8, Sect.1-2, 2nd bullet, second sentence: Add total dissolved solids to the list and change "nutrient" to micronutrient".

  Response: The text will be modified accordingly.

  Resolution:

- Comment #2, Page 2-32, Sect. 2.5.5, first paragraph, last sentence: The discrepancy between the predictions of the model cited and the USGS model should be included. The range of estimates from both models should be included throughout this discussion. In terms of estimating potential changes to the physiochemical parameters of Snake Pond, it is more prudent and conservative, from an impacts assessment standpoint, to use the estimate that may indicate a higher level of impact.

  Response: The text will be changed to reflect the range of estimates from the models.

  Resolution:

- Comment #3, Page 2-33, Sect. 2.5.5, second paragraph, second, fourth, fifth, and seventh sentences: [in second sentence] change "17% rainfall" to "14 to 17% rainfall" and add the USGS values so that the ranges are included in the rest of this sentence. [in fourth sentence] add "to 67%" after "approximately 30%. [in fifth sentence] add "0.3 to" before "0.7 (ambient concentration0". [in seventh sentence] add "to 70%" After "Based on 30% and "to 1.4 (degrees) F" after "0.7 (degrees) F".

  Response: As stated previously, the text will be changed to reflect the range of estimates from both of the models.

  Resolution:

- Comment #4, Page 2-34, Sect. 2.5.5, first paragraph, second sentence: delete "and natural buffers". Snake Pond has, for practical purposes, no buffering capacity with an alkalinity at less than 5 mg/L.

  Response: The change will be made to the text.

  Resolution:

- Comment #5, Page 2-34, Sect. 2.5.5, second paragraph, second sentence: Add at a minimum "overall total of" before "inorganic carbon-". The form of the inorganic carbon available in the pond will be substantially changed from the predominantly free dissolved CO-2 (a form preferred by the submerged aquatic photosynthesizers - algae and macrophytes) at pH 6 to a 70% reduction of the free CO-2 form at pH 7 with an equivalent increase in the bicarbonate fraction at the pH 7.

  Response: The suggested text change will be made. The remainder of the comment is a statement of fact and requires no comment or change to text.

  Resolution:

- Comment #6, Page 2-34, Section 2.5.5, third paragraph, second sentence: and the sentence after the word "predicted". Add a sentence something like: "It is likely that the groundwater supplies an important portion of the TOC in the pond system as groundwater comprises around 85% of the total pond water budget and ambient groundwater has about five times more TOC (5 mg/L) than was measured in Snake Pond water in July 1996 (1 mg/L)."

  It is NOT likely that biologic activity within Snake Pond dominates the TOC budget in this pond.

  Snake Pond TOC was measured at around 1 mg/L in late July while the groundwater ambient values are around 5 mg/L. Also the low alkalinity further supports that there is low productivity in this system, hence it is unlikely that the biotic activity is dominating the pond concentration of TOC, especially in view of the high percentage of groundwater entering this system.

  Response: The text will be modified as appropriate.

  Resolution: This topic has been discussed on several occasions since the comment response was submitted. Several statements have been determined to be incorrect and, therefore, the text of the design report will not be modified.

  The comment states that the ambient groundwater has about five times more TOC (5 mg/L) than was measured in Snake Pond (1 mg/L). The TOC concentration of 5 mg/L was detected in a sample that was obtained from a monitoring well located within the boundaries of the FS-12 plume and therefore does not represent the ambient TOC concentration of the groundwater. The background TOC of the groundwater is actually closer to 0.5 mg/L. Additionally, with the removal of several of the reinjection wells in the vicinity of Snake Pond from the original design basis, it is more likely that the groundwater will comprise 35% to 70% of the total pond water budget, as opposed to 85%.

  It is likely that biologic activity within Snake Pond dominates the TOC budget in the pond.

  These topics will be addressed in further detail in the draft Ecological Sampling and Analysis Plan for FS-12, which is scheduled for submission on March 21, 1997.

- Comment #7, Page 2-34, Sect. 2.5.5, fourth paragraph, fourth sentence: Correct "9%" to "90%".

  Response: The text will be modified accordingly.

  Resolution:

- Comment #8, Page 2-35, Sect. 2.5.5, second bullet: Delete the "Dissolved Inorganic Carbon" bullet. See information in comment test of comment 5. The treatment system, depending on the pH alteration, can have a substantial impact that would contribute to further lowering primary production in this pond system.

  Response: The bullet will be changed to "Total Dissolved Inorganic Carbon.

  Resolution:

- Comment #9, Page 3-7, Sect. 3.1.6, third paragraph in Sect. 3.1.6, second sentence: Would like more details included in text on the dosage, and likely sphere of impact when shocking or continuously feeding the NaOCl biocide.

  Response: The current design provides piping connections that will allow the continuous addition of up to 2 mg/l free chlorine, if required, to control generalized fouling in the wells. Chlorine is not

stable in the environment, it tends to react with any organic material present such as bacteria or soil humus. So, the chlorine should not exist very far from the well. A literature search was conducted to determine if information was available on how far the chlorine could migrate. No useful information was found so the current design basis is to add hypochlorite only if a plugging problem occurs that requires control., If the hypochlorite is added, samples will be collected from downgradient monitoring wells to insure that free chlorine is not migrating from the site.

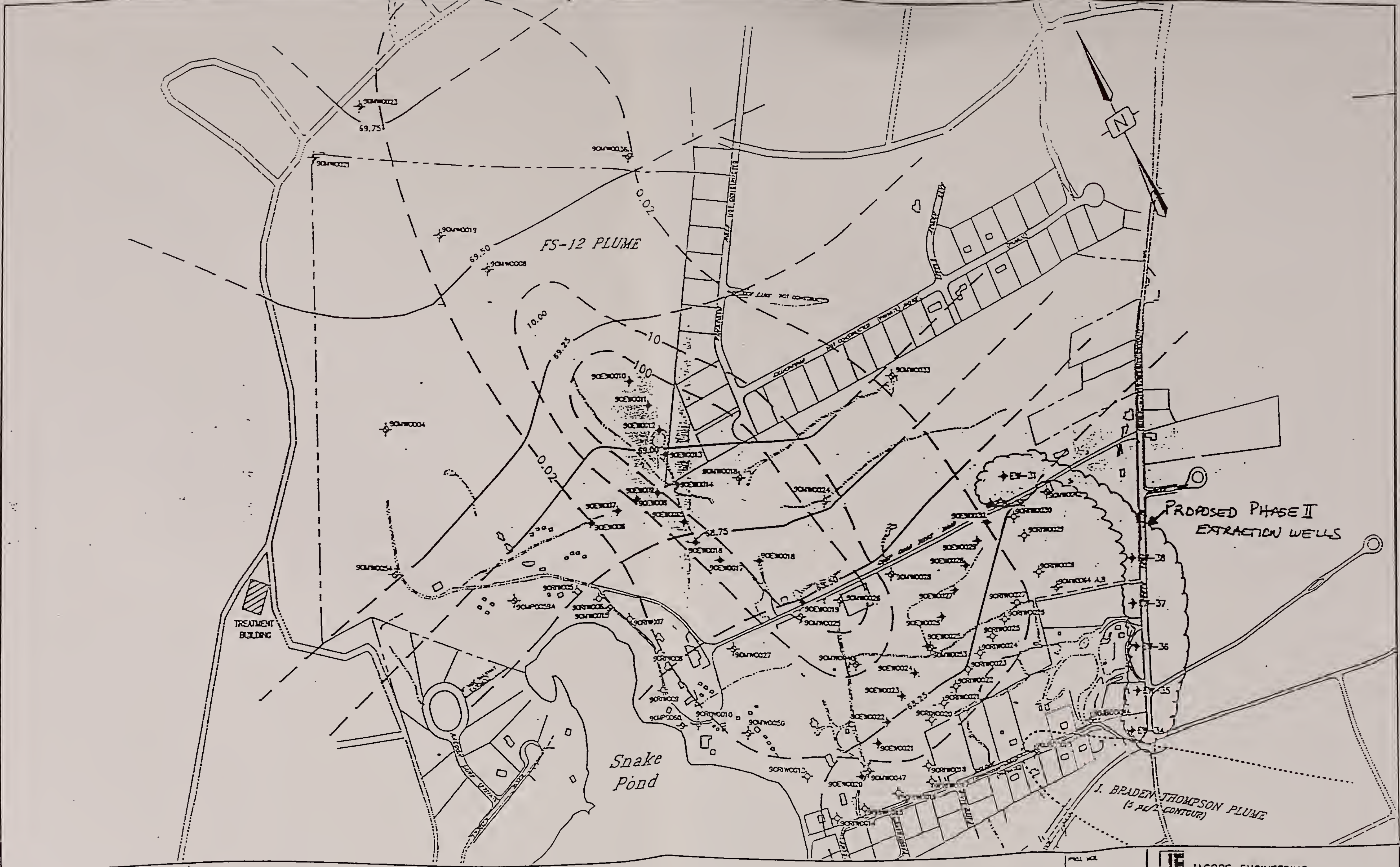
If individual wells lose capacity because of biological plugging, those individual wells can be given "shock loadings" of hypochlorite. Shock loading uses free chlorine concentrations as high as 500 mg/l to 2000 mg/l, frequently combined with re-development of the well and acid washing. If "shock loading" is required it will be performed at individual wells, using standard procedures for disinfecting water wells.

Resolution:

- Comment #10, Page 3-25, Sect. 3.2.2, last paragraph: Please update this information here AND where ever else test is appropriate as to the pH requirements from the state with regards to the effluent requirements.

  Response: There are no Commonwealth of Massachusetts requirements for treated water that will be reinjected into the subsurface.

  Resolution:



I:\AUTOCAD\01(FS12)\07-PLUE\07FIG1-3.DWG

DRAFT

GENERAL NOTES

1. [illegible]
2. [illegible]
3. [illegible]

LEGEND:

- 9CEWC010 EXTRACTION WELL
- 9CRIWC020 REINJECTION WELL
- 9CMWC030 MONITORING WELL
- GROUNDWATER ELEVATION CONTOUR
- 10 FS12 EDB PLUME (CONCENTRATIONS IN µg/l)
- J. BRADEN THOMPSON PLUME (5 µg/l TOTAL VOC CONTOUR)

NOTE:
- Groundwater level measurements collected on November 25, 1996.

0 250 500 1000
SCALE IN FEET

PROJ. MGR. R.Lona	JACOBS ENGINEERING
PROJ. ENG. P.Nixon	FS-12 Plume Location & Extraction/Reinjection Well Locations MASSACHUSETTS MILITARY RESERVATION Cape Cod, Massachusetts
DRAWN BY DJ	
DRAWING NO. 97FIG1-3.DWG	
REVISION DATE 3/25/97-NON	
DATE 3/25/97	PROJ. NO. 35K78404 — FIGURE 1

cc:

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December 8, 1997

Mr. Jim F. Snyder
Remediation Program Manager
HQ AFCEE/MMR
322 East Inner Road, Box 41
Otis ANG Base, MA 02542-5028

RE: Final Design Report for FS-12 Containment System

Dear Mr. Snyder:

As directed by the Air Force Center for Environmental Excellence, Jacobs Engineering Group Inc. is hereby providing twenty seven bound copies and one unbound copy of the addendum letter and attachments for the *Draft Design Report for FS-12 Containment System*, dated October 1996. The designated number of copies are also being sent to the United States Environmental Protection Agency, the Commonwealth of Massachusetts Department of Environmental Protection, the United States Army National Guard, and other recipients of the original document.

This addendum includes a letter updating what has occurred on the project since the draft report was written, a current well field layout, and the comments/responses/resolutions to the draft document. Please incorporate this addendum document into your Draft Design Report. If you were not on the initial distribution list, individual requests for a full set of the original draft documents will be honored until January 15, 1998.

This addendum letter and attachments now complete the necessary protocols with the regulator and AFCEE concurrence to make the Design Report a final document.

Please feel free to contact Larry Eitel or myself at (508) 564-5746 extension 264, if you have any questions or comments.

Sincerely,

Thomas W Gorges

Thomas W. Gorges
Program Manager

Enclosure: Document (28)

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